

Characteristics of Reproductive Biology for *Larix* Originating in Japan

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Abstract The paper summarized the life cycle, environmental features and distributions of *Larix* origination in Japan. The time of blooming and fruiting and the ways of cone collection and seeds storage were introduced. The treating methods of seeds germination and the sowing time for both Japanese larch (*Larix kaempferi* Carr.) and Dahurian larch (*Larix gmelinii* var. *japonica* Pilger) were discussed.

Key words: Reproductive biology; *Larix kaempferi*; *Larix gmelinii*

Species and Distribution of Larch

There are 15 species of *Larix* in the world. They mainly distribute in the frigid-temperate zone of the Northern Hemisphere and the Himalayas in China. There are only one species and one variety of *Larix* which distribute in Japan, namely, Japanese larch (*Larix kaempferi* Carr.) and Dahurian larch (*Larix gmelinii* var. *japonica* Pilger).

Japanese larch distributes in a narrow area, only in the alpine in Honshu. The north of horizontal distribution is in Miyagi County (alt. 1565 m, $38^{\circ}5'N$), the southern distribution is in Shizuoka County (alt. 1366 m, $35^{\circ}8'N$), and the center distribution is the middle of Honshu and the region of Kanto. Its vertical distribution is usually from *Fagus* forests, sub-alpine, even to alpine. Pure forests of Japanese larch usually form in the bare land of fire site, mud-rock flow and landslide. The range of vertical distribution is from altitudes 900 to 1850 m in northeast, from altitudes 1300 to 2400 m in Kanto, from altitudes 1000 to 2800 m in the middle of Honshu, the lowest boundary is altitudes 900 m in Fukushima, the highest boundary is altitudes 2800 m in Fuji Mountain where Japanese larch lives in the tree line and shows dwarf shape.

Japanese larch is a typical heliophytes, poorly grows under shade condition, but with resistance to drought and barren. It also distributes in the primary bare land with volcano ash and volcano lava and in the second bare land caused by the snowslide and the mud-rock flow. Although its natural distribution area is very narrow, Japanese larch is a very important afforestation tree species.

Dahurian larch distributes in Etorofu and Shikotan of

Chishima and Sachalin. It always forms pure forest along the cold and humid coast and shows dwarf shape owing to be affected seriously by the sea wind.

In the sub-alpine of the North in Hokkaido, the cold resistance of Dahurian larch is stronger than that of Japanese larch. It is also a very important afforestation tree species for its straight trunk and excellent quality of wood.

Blooming and Fruiting

All of species of *Larix* are unisexual flower. Pistillate and staminate flower usually live in everywhere of crown. However, most of them are in the middle of a crown on sunny side. The locations of the flower gradually move to the upper of the crown as age increasing. It was reported that 70%-80% of pistillate flower lived in the above middle part of a crown in mature trees.

Twigs with flower grow slowly. The angles between branches and trunk show right angles or an obtuse for the maternal plant with high quality fruit, and their twigs hang down. The pistillate and staminate flowers of Japanese larch all appear on short twigs. The pistillate is always on the short twigs of 3-5 years old, and the staminate one is on the twigs of 2-5 years old. The position of pistillate and staminate flowers on twigs for Dahurian larch is very similar to that of Japanese larch. Most of flowers are on the 3 ~ 5 years old branches. However, flowers are on the new branches at 1 ~ 3 years old when plant is grafted. Some pistillate of flower variable is always on the top of branches and axes of cone elongate.

The flower buds of Japanese larch have differentiated in the year before blooming and fruiting. In general, the

differentiation time is from the first ten days to the last ten days of July. The time of differentiation in Hokkaido is one or two weeks earlier than that in Nagano County, and there is no significant different by altitudes.

The staminate and pistillate flowers bloom in spring of the next year. The blooming condition is related to not only the growing condition of a tree, but also the weather. In June or July, the condition of high temperature, little rainfall and long sunshine are helpful for flower buds differentiating. However, weather also strongly affects the blooming date of Japanese larch. Japanese larch blooms in the second ten days or last ten days in April at altitude 1000 m near Nagano County, and in the first ten days or second days of May near the forest in Fuji Mountains. The blooming date in the middle in Hokkaido is always one or two weeks later than that of Honshu.

The blooming date for Dahurian larch is in the last ten days of April, universally earlier than that of Japanese larch in Hokkaido. Therefore Dahurian larch from Sachalin provenance blooms in the first ten days in May or June.

Due to the same blooming date of the pistillate and staminate flowers, bract scales of Japanese larch begin to curve after blooming and have been pollinating before the micropyles are covered. Bract scales nearly horizontally spread out during the fittest period of fertilization until young leaves come. Pollen disperse at high temperature and low humid day. Pollen fertilized stay in micropyle for 6 ~ 7 weeks until the pollen tube come out. The pollen fertilization stage in Nagano County is usually during the first ten days or last ten days of June, and one or two weeks earlier than that in Hokkaido. The cone size is nearly the same as the mature the second ten days in June, and then young embryos develop and mature in autumn in the same year.

The twigs of flower buds will be dead after blooming and fruiting, which cover 50% of all twigs. And these twigs grow slowly. So the time between the two harvest years becomes quite long, about 3 ~ 5 years on an average.

Seeds of Japanese larch are not allowed to collect until the first of September in order to get high germination rate. After maturity seeds still stay in cones for very long time. It is very difficult to determine the collecting time of cone by leaves color. Therefore, it is very necessary to know the time of mature seeds dispersing and germination rate. A few seeds begin to germinate in the end of July for Dahurian larch, and on 20th of August of Japanese larch near Furano in Hokkaido. The germination rate of seeds is highest during seeds dispersing in the first ten days in September

for Dahurian larch and on the 10th of October for Japanese larch.

High quality of seeds is relation to the size of maternal plants, which are affected by the condition of soil, sunlight and other environmental factors. Dahurian larch is able to bear fruit when it reaches 14 or 15 years old, 5 ~ 6 cm d.b.h.(diameter at breast height). It bears high quality seeds when it is in 30 ~ 38 years old, 10 ~ 25 cm d.b.h..

The index of a harvest year is that the number of individuals bearing fruit cover above 30%. The number of branches bearing fruit are above 30%. The number of bearing cones in each branches is not less than 10; but above index for low productive year is respectively: under 20%, 20% and 5.

Collection and Treatment of Seeds

Cones of Japanese larch show obovate globular shape or ovate elliptical shape, 2.5 cm in length, 2.0 cm in diameter. The cones size is closely relation to producing place and soil condition. One cone has 40 ~ 50 scales. The top of cone scales curves inside-out in mature. Color is from light dark-green to yellowish-brown. Seed's color shows grey-brown, triangle and 4 mm long with wings.

Cones of Dahurian larch exhibit ovate round shape, and less than that of Japanese in size. For each cone, there are 5 layer cone scales, 20 ~ 25 cone scales, not curving in maturity. The mature cones show purple-brown and seeds reveal light brown, triangle and 3 mm long with wings.

The best way of harvesting cones is directly collecting cones one by one with appropriate tools. Cutting the branches which bear fruit may reduce the production next year and destroy growth of the tree.

Their moisture content and open degree of cone scales affect weight and volume of fresh cones. The number and weight per kilogram of cones showed in Table 1.

Table 1. Weight and number of cones

Species name	Number of cones /Number · kg ⁻¹	Number of cones /Number · L ⁻¹	Weight /Gram·L ⁻¹
<i>L. kaempferi</i>	399 (352 ~ 490)	142	355 (277 ~ 416)
<i>L. gmelini</i> var. 2148		565	263
<i>japonica</i>			

Collected cones must be quickly unfolded on the well-ventilate and sunshine place, to open cone scales and get seeds out. When a large number of cones are treated, for easy to open up cone scales, some people first sprinkle cold water on them, then put them on the full of sunlight place. Some people make cones dry artificially with fire,

but must pay attention to temperature and ventilation. Moreover, the cones with high moisture content must be dry naturally, otherwise theirs germinate rate would reduce. After dry fully, seeds are put in bag to take off wings by scrubbing.

It is very difficult to judge if seeds are mature by appearance. We usually select seeds by wind or water.

Germination

Air-dry seeds contain 10% water. In order to make seeds germinate easily, we must add 92% ~ 165% water of dry weight of seeds. Seeds can quickly absorb 40% ~ 50% water during the first two days. Over water may produce disease and bacterium and influence the vitality of seeds. The most appropriate temperature for germination is 26 ~ 30 °C, the highest is 35 ~ 36 °C and the lowest is 8 ~ 9 °C. Usually the fixed temperature is at 23 ~ 36 °C or variable temperature is at 30 °C(8 h) ~ 20 °C(16 h). The condition of germination is better in dark than in light.

Covering seeds with earth at low temperature with snow is helpful to germinate. It is demonstrated that there are excellent results after it was treated respectively in one month at 0 °C and 5 °C, but also there are satisfied results after it was treated in one month at 0 °C or 5 °C. It is better to put them at room temperature for several hours after seeds are treated at low temperature, and appropriate irradiating seeds with X-ray may accelerate germination.

Germinate rate is affected by many factors, age of maternal plant, the ways to making cones dry, etc.

Storage

Seeds must be maintained because there are 3 ~ 5 years long between harvest years for larch. Seeds usually are stored in sealed wide-mouth bottle with drying agent at low temperature.

Sowing

Usually sowing in spring, the number is determined according to germinate rate and number of seeding. When earth temperature is above 8 °C, seeds are treated with snow in prepared seedbed and covered with a little earth. Seeds germinating, field management should be properly conducted.

If you want to seedlings coming out earlier in spring for larch, you can sow disinfected seeds in autumn last year, the latter can get more seedlings than the former.

Reference

1. Asakawa S., Katsuta M., Yokoyama T., 1981. Seeds of Woody Plants in Japan. Japan Forest Tree Breeding Association, Tokyo.
2. Farjon A., 1990. Pinaceae. Koeltz Scientific Books, Konigstein.

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